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FEC

PRICE $5.00

POWER SUPPLY

E 204

INSTRUCTION MANUAL

KEPCO INC.®

131-38 SANFORD AVENUE • FLUSHING, N. Y. 11352
Area Code 212 IN 1-7000 • TWX # 212-539-6623

SERIES CONNECTION

Kepco Voltage Regulated Power Supplies can be connected in series for increased voltage, provided the specified limits on the voltage to chassis are not exceeded. When series connected, supplies should be protected by means of a semiconductor diode, reverse-connected across the output terminals of each power supply. The peak reverse voltage (PRV) rating of this diode should be chosen to be at least as large as the voltage rating of the supply to which it is connected. The forward (continuous) current rating of the diode should be capable of

INSTRUCTION MANUAL

VOLTAGE REGULATED POWER SUPPLY

MODEL SM 325-2,M

SERIAL NO. C-22631

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131-38 SANFORD AVENUE · FLUSHING, N.Y. 11352 · PHONE: (212) IN 1-7000 · TWX # 212-539-6623

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SECTION A SPECIFICATIONS

I. ELECTRICAL AND PHYSICAL SPECIFICATIONS:

.....DC OUTPUT VOLTAGE:
0-325 volts DC, continuously variable.

.....DC OUTPUT CURRENT:
0-2 amperes, continuous duty.

.....AC INPUT:
105-125 volts, 60 ± 1/2 cps., 950 watts (maximum).

.....REGULATION:
Line: Less than 0.1% for 105-125 volts AC line fluctuations at any output voltage in the specified range.
Load: Less than 0.1% or 0.003 volt, whichever is greater, for 0-2 amperes load change, at any output voltage in the specified range.

.....RIPPLE:
Less than 0.001 volt rms.

.....STABILITY:
Output voltage variation is less than 0.1% or 0.006 volt, whichever is greater, over a period of 8 hours after unit has reached equilibrium. Approximately 3/4 of an hour is required for this unit to reach equilibrium from a "cold start."

.....OUTPUT IMPEDANCE:
Less than 0.2 ohm from 60 CPS to 1 KC.
Less than 1.0 ohm from 1 KC to 100 KC.

.....RECOVERY TIME:
50 microseconds.

.....TEMPERATURE COEFFICIENT:
Output voltage changes less than 0.05% per °C.

.....AMBIENT OPERATING TEMPERATURE:
-20°C to +50°C maximum. Protective circuit turns off unit whenever over-temperature condition occurs. Interrupting input power resets unit.

.....STORAGE TEMPERATURE:
-40°C to +85°C.

.....DIMENSIONS:
8-3/4" high x 19" wide x 13-7/8" deep (behind panel).

.....COLOR:
Kepco Standard Gray Hammertone.

.....METERS (If specified):
Voltmeter: 0-400 volts, 2-1/2".
Ammeter: 0-2 amps, 2-1/2".

II. TERMINALS AND CONTROLS:

.....(On front panel):

....DC OUTPUT AND GROUND binding posts, clearly marked. Output terminals isolated from chassis; either positive or negative terminal may be grounded.
....VOLTAGE CONTROL, continuously variable, for setting the output voltage at any desired value within the rating of the supply.
....POWER ON-OFF toggle switch interrupts line input.

.....(At rear of unit):

....DC OUTPUT AND GROUND binding posts, clearly marked; either positive or negative terminal may be grounded.
....REMOTE ERROR SENSING binding posts provide means of maintaining specified regulation directly at the load by compensating for voltage drops across load supply leads for up to 0.5 volt per lead (maximum). (See Diagram and Procedure on Page C-1.)

III. PROTECTIVE FEATURES:

....REFERENCE FUSE for input to the auxiliary supplies. Pilot light goes out if fuse blows; fan stops.
....POWER FUSE for line power input. Pilot light goes out if fuse blows; fan stops.
....DC FUSE for main supply. Pilot light remains on if fuse blows; fan remains operative.

.....OVERLOAD PROTECTION:
Provided by inherent current limiting action of FLUX-O-TRAN. Output may be shorted momentarily without damage to unit. Continuous overload or short will blow DC FUSE.

.....OVER-TEMPERATURE PROTECTION:
Thermostat relay control turns unit off if temperature of pass elements exceeds safe limit. Unit must be reset by interrupting input power with ON-OFF toggle switch on front panel or by disconnecting line cord from power source.

SECTION B

BRIEF THEORY:

Two circuit schematic drawings titled "POWER UNIT" and "CONTROL UNIT" are included in the Reference Index of this instruction manual. These drawings contain designations corresponding to the capitalized terms in the following discussion.

Some basic functional relationships in this power supply are illustrated in block Diagram B-1 (Page B-2A).

The POWER UNIT includes:

DC SOURCES:

....MAIN SUPPLY - (consisting of a Kepco "Flux-O-Tran" transformer, full wave bridge rectifier, and capacitive filter) provides line regulated DC power for the output, via the PASS CIRCUITRY.

....AUXILIARY SUPPLIES: COLLECTOR SUPPLY (negative full wave rectified) for PASS CIRCUITRY driver stages not connected to MAIN SUPPLY; I_{CO} SUPPLY (full wave rectified) compensates for spurious biasing effects of collector leakage current; RETURN SUPPLY (full wave rectified) acts as leakage current path for series pass transistors and as bleed path to provide minimum operating current for pass transistors; CONTROL UNIT SUPPLY (full wave rectified).

PASS CIRCUITRY:

The power transistors which function as pass elements (i.e. are in series with the load) may be regarded effectively as variable resistors (or conductors) controlled by a CONTROL SIGNAL. The current "passed" by these elements is a function of the emitter-base bias. The CONTROL SIGNAL is applied to the base terminal; hence a negative CONTROL SIGNAL will aid the forward conduction of a PNP transistor while a positive CONTROL SIGNAL will reduce the forward conduction. In response to the CONTROL SIGNAL the pass elements effect a current and voltage distribution in the main DC loop which holds the output voltage constant.

The CONTROL UNIT includes:

REFERENCE CIRCUITRY:

The function of the REFERENCE CIRCUITRY is to maintain a precise, stable, voltage standard for the COMPARISON AMPLIFIER.

COMPARISON AMPLIFIER:

The COMPARISON AMPLIFIER is essentially a series of cascaded transistor amplifiers which boost the differential error signal produced in the COMPARISON BRIDGE to a level sufficient to drive the PASS CIRCUITRY. The COMPARISON AMPLIFIER is connected across the COMPARISON BRIDGE from the junction of the VOLTAGE CONTROL and the REFERENCE RESISTANCE to the junction of the REFERENCE DIODE and the negative output terminal (See Diagram on Page B-2A). This arrangement is similar to that of a null galvanometer across a Wheatstone bridge. Unbalance in the COMPARISON BRIDGE is amplified to produce a CONTROL SIGNAL of suitable magnitude and phase to effect corrective action by the PASS CIRCUITRY.

COMPARISON BRIDGE: (See Diagram B-2, Page B-2A).

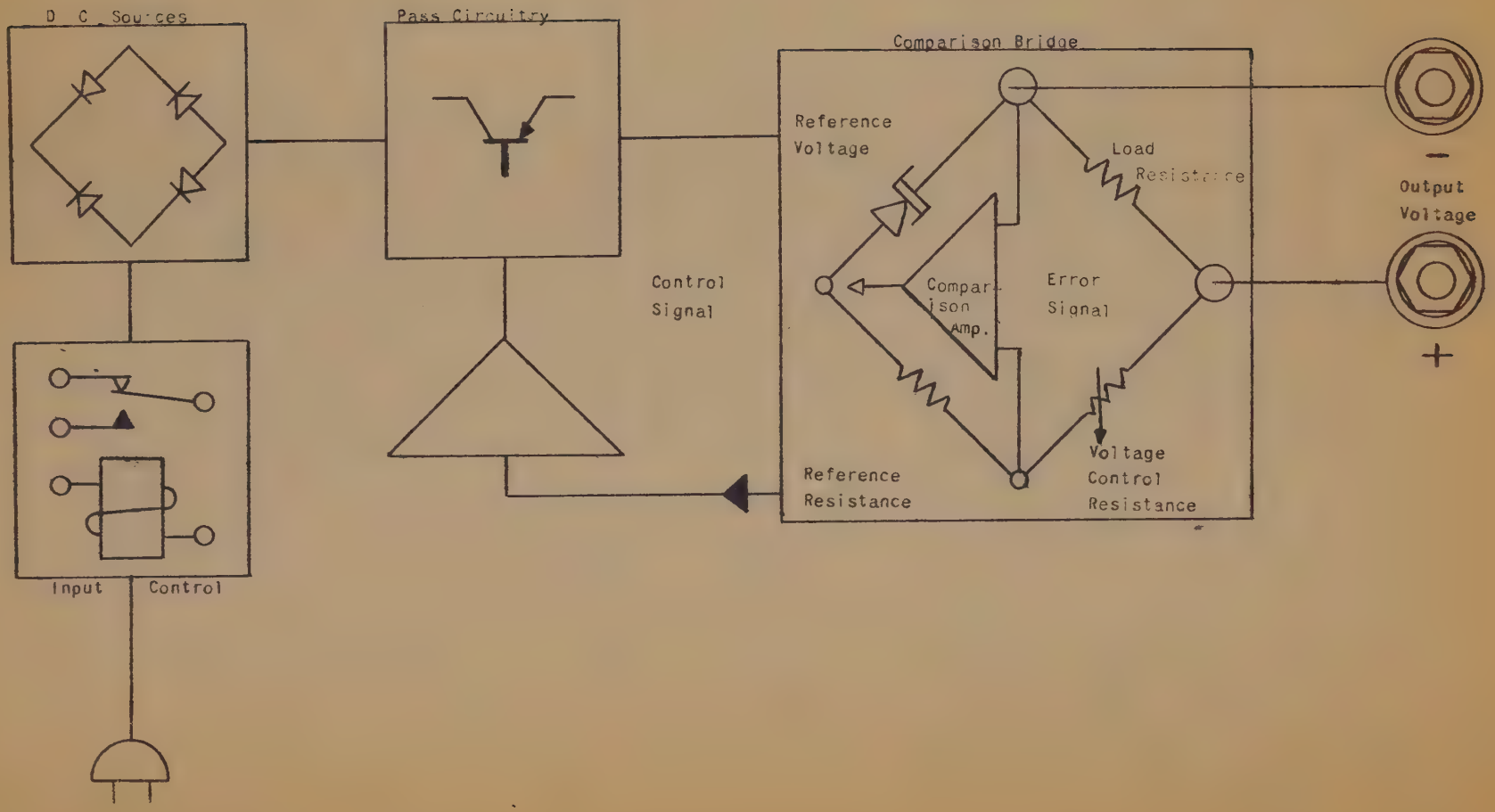
This bridge circuit implements the comparison between the OUTPUT VOLTAGE and the REFERENCE VOLTAGE. The signal produced by the comparison drives the COMPARISON AMPLIFIER.

Balance occurs in the Comparison Bridge when the following ratios are equal:

$$\frac{\text{Output Voltage}}{\text{Voltage Control Resistance}} = \frac{\text{Reference Voltage}}{\text{Reference Resistance}}$$

When, for example, the Comparison Bridge is unbalance by a decreasing output voltage drop across the load, it gives rise to a negative signal at the base of the COMPARISON FOLLOWER in the COMPARISON AMPLIFIER circuit. This signal is amplified in cascade and communicated to the pass elements as a negative base input aiding their forward conduction and consequently increasing the output voltage.

A bridge unbalance caused by an increasing output voltage produces, of course, a chain of oppositely biased circuit responses which reduce the voltage across the load.


D C Sources
Pass Circuitry
Comparison Bridge
Reference Voltage
Load Resistance
Output Voltage
Control Signal
Compar-ison Amp.
Error Signal
Input
Control
Reference Resistance
Voltage Control Resistance

THIS POWER SUPPLY:

....is shipped without any internal packing material and may be put into operation right away.

....is designed for rack or bench use. Carrying handles are provided on front panel.

....requires no mechanical maintenance of any kind, under normal operating conditions.

....incorporates carefully selected and tested components which assure long trouble free operating life. However, resistor board construction and plug-in sub-assemblies provide exceptional component accessibility should servicing be required. Any servicing should be handled by personnel experienced in transistor circuitry. Serious and costly damage can result from inexperienced probing.

....should not be returned to the factory without proper authorization and shipping instructions. In any correspondence with the factory concerning repair, the model and serial number of the instrument must be supplied together with a description of the trouble encountered.

INITIAL "TURN-ON" PROCEDURE:

1. Rotate voltage control to approximate mid-range position.

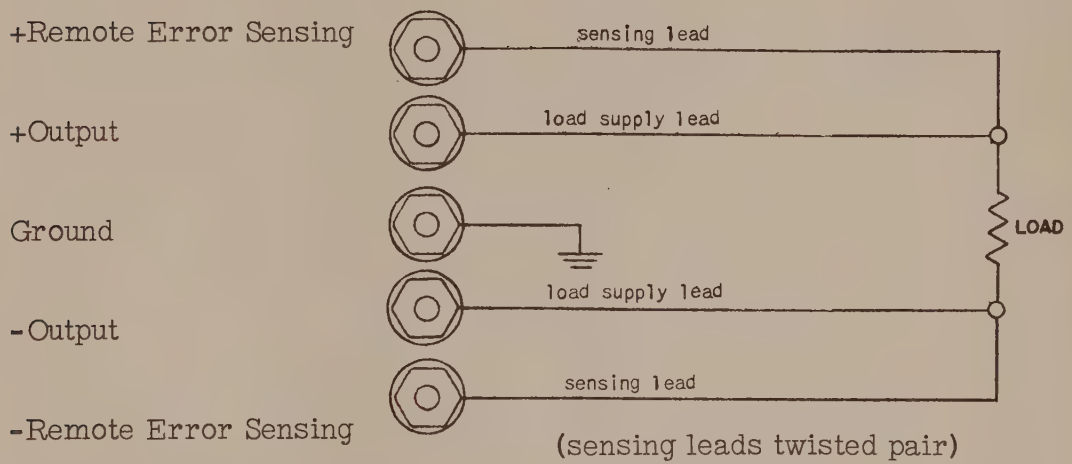
2. With power ON-OFF switch in "OFF" position, plug line cord into 115 VAC 60 cps power receptacle. If the outlet is not polarized, use 3 to 2 prong adaptor supplied with unit.

3. Turn power ON-OFF switch to "ON" position.

4. Set output voltage to desired value by rotating voltage control.

REMOTE ERROR SENSING OPERATION

(Terminal Connections)



(sensing leads twisted pair)

(Procedure)

1. With AC input power disconnected, remove jumpers between plus and minus Output terminals and Remote Error Sensing terminals on the rear of the unit.

2. Using twisted pair wire, connect sensing leads from positive and negative Remote Error Sensing terminals to the load (observing polarities).

3. Using twisted pair wire, connect load supply leads from positive and negative Output terminals.

IMPORTANT NOTE: This unit should not be operated with Remote Error Sensing if the voltage drop across the load supply leads exceeds 0.5 volt (maximum) per lead at maximum rated output current.

Schematic Part No.	Kepco Part No.	Description	Specifications			Mfr.	Mfr's. No.
		Capacitors:					
C1, 2	117-0128	Mylar	0.4 uf	200 v	10%	Hopkins	P42M
C3	117-0223	Electrolytic, Pigtail	25 uf	25 v	+100-10%	Industrial Cond.	1B1171RM
C4	117-0207	Mylar	1 uf	200 v	10%	Hopkins	1P2M
C5	117-0048	Paper	0.002 uf	600 v	20%	Cornell-Dubilier	BUDROC
CR1, 2	124-0084	Silicon Rectifier, Pigtail				Transitron	SL91
F1	141-0022	Fuse, Slow Blow	0.2 A			Bussman	MDL-2/10
Q1	119-0022	Transistor, PNP				Tung-Sol	2N382
Q2	119-0007	Transistor, NPN				Gen. Transistor	2N35
Q3-5	119-0024	Transistor, NPN				Gen. Transistor	GT1092
Q6	119-0034	Transistor, PNP				Delco	2N1172
		Resistors:					
R1	115-0560	Fixed, Molded	2.7 K ohms	1/2 w	10%	Allen-Bradley	EB2721
R2	115-0689	Fixed, Molded	15 ohms	1/2 w	10%	Allen-Bradley	EB1501
R3	115-0808	Fixed, Molded	3.9 K ohms	1/2 w	5%	Allen-Bradley	EB3925
R4	115-0920	Fixed, Molded	13 K ohms	1/2 w	5%	Allen-Bradley	EB1335
R5	115-0502	Fixed, Molded	10 ohms	1/2 w	10%	Allen-Bradley	EB1001
R6, 17	115-0888	Fixed, Molded	560 ohms	1/2 w	5%	Allen-Bradley	EB5615
R7	115-0608	Fixed, Molded	470 ohms	1/2 w	10%	Allen-Bradley	EB4711
R8	115-0459	Fixed, Power, Axial	500 ohms	3 w	5%	Ward Leonard	3X50WL
R9	115-0565	Fixed, Molded	620 ohms	1/2 w	5%	Allen-Bradley	EB6215
R10	115-0484	Fixed, Molded	240 ohms	1/2 w	5%	Allen-Bradley	EB2415
R11	115-0473	Fixed, Molded	1.8 K ohms	1/2 w	10%	Allen-Bradley	EB1821
R12	115-0467	Fixed, Molded	4.7 K ohms	1/2 w	10%	Allen-Bradley	EB4721
R13	115-0002	Fixed, Molded	100 ohms	1 w	10%	Allen-Bradley	GB1011

Schematic Part No.	Kepco Part No.	Description	Specifications			Mfr.	Mfr's. No.
R14	115-0005	Fixed, Molded	47 ohms	1 w	10%	Allen-Bradley	GB4701
R15	115-0466	Fixed, Molded	2.2 K ohms	1/2 w	10%	Allen-Bradley	EB2221
R16	115-0566	Fixed, Molded	750 ohms	1/2 w	5%	Allen-Bradley	EB7515
R18	115-0739	Variable, Wire Wound	1 K ohms	1/4 w	10%	Bourns	271-1-102
RD1	121-0013	Reference Diode				Hoffman	RS-6

Schematic Part No.	Kepco Part No.	Description	Specifications	Mfr.	Mfr's. No.
B201	149-0013	Fan, Venturi		Rotron	Muffin Fan
		Capacitors:			
C201-203	117-0249	Electrolytic, Can	1.1 K uf 440 v +50-10%	Industrial Cond.	40B808
C204	117-0238	Paper, Can	8 uf 660 v AC 5%	Industrial Cond.	2465-SVR
C206	117-0208	Mylar	0.5 uf 600 v 5%	Hopkins	P56M
C301	117-0087	Ceramic	0.1 uf 500 v +80-20%	Sprague	41C92
C302	117-0147	Electrolytic, Pigtail	10 uf 150 v +50-10%	Industrial Cond.	10B912RM
C401	117-0114	Electrolytic, Pigtail	350 uf 50 v +100-10%	Industrial Cond.	1B844
C402	117-0222	Electrolytic, Pigtail	100 uf 200 v +50-10%	Industrial Cond.	20B317RM
C403, 404	117-0221	Electrolytic, Pigtail	500 uf 50 v +100-10%	Industrial Cond.	1B1163RM
C405, 406	117-0163	Ceramic	0.05 uf 500 v 20%	Sprague	36C142A1
C501	117-0151	Electrolytic, Pigtail	20 uf 450 v +50-10%	Industrial Cond.	45RM20
C502	117-0208	Mylar	0.5 uf 600 v 10%	Hopkins	P56M
		Rectifiers:			
CR201	124-0090	Silicon, Stack		Kepco	124-0090
CR301-304, 403, 404	124-0028	Silicon, Pigtail		Automatic	PT-5
CR401, 402, 405, 408	124-0084	Silicon, Pigtail		Transitron	SL-91
F101	141-0010	Fuse, Instantaneous	15 a 250 v	Bussmann	ABC-15
F102	141-0028	Fuse, Slow Blow	3 a 125 v	Bussmann	MDX-3
F401	141-0012	Fuse, Instantaneous	2 a 250 v	Bussmann	AGC-2
M101	135-0157	Meter	400 v DC 2-1/2 v	G.E.	8DW91V206AY2
M102	135-0154	Meter	2 a DC 2-1/2 v	G.E.	8DW91A225BR2

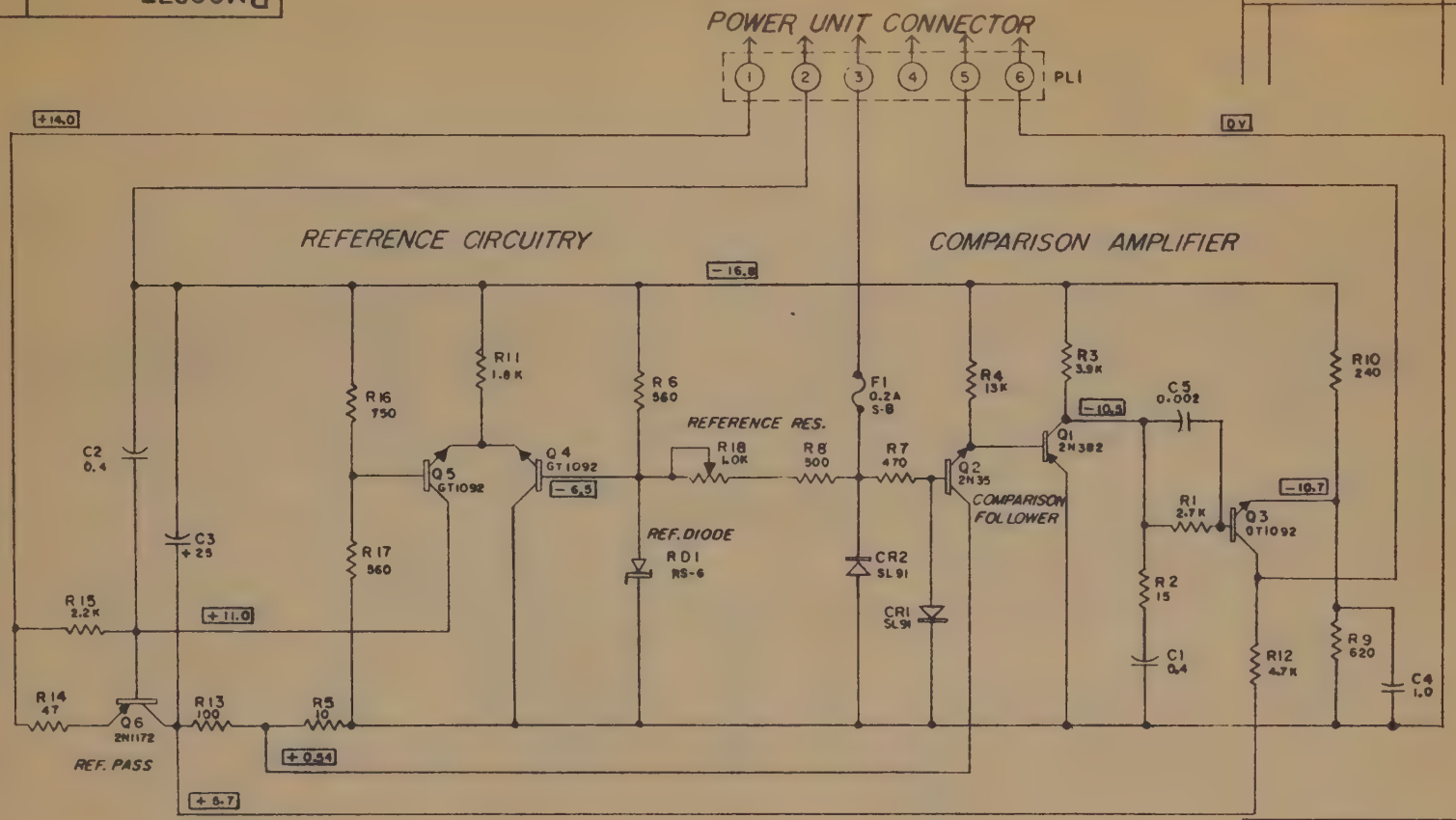
Schematic Part No.	Kepco Part No.	Description	Specifications			Mfr.	Mfr's. No.
PL101	153-0024	Pilot Light				G.E.	NE-51
Q301	119-0022	Transistor, PNP				Tung-Sol	2N382
Q302	119-0034	Transistor, PNP				Delco	2N1172
		Resistors:					
R201	115-0977	Fixed, Power, Strip	1.5 K ohms	40 w	5%	Ward Leonard	40S1500
R202	115-0727	Fixed, Power, Strip	10 ohms	20 w	5%	Ward Leonard	20S10
R203	115-0594	Fixed, Power, Strip	100 ohms	40 w	5%	Ward Leonard	40S100
R205	115-0770	Fixed, Power, Strip	10 K ohms	20 w	5%	Ward Leonard	20S10000
R206, 207	115-0942	Fixed, Power, Ribbon	2.5 ohms	110 w	5%	Ward Leonard	4-1/2"-B Core-2.5 ohms - Ribflex - 5%
R208	115-0892	Fixed, Power, Ribbon	1 ohm	75 w	5%	Ward Leonard	3-1/2" - B Core-1 ohm - Ribflex - 5%
R209	115-0552	Variable, Wire Wound	50 K ohms	4 w	5%	General Radio	975-Q
R210, 211	115-0513	Fixed, Power, Strip	1 K ohms	40 w	5%	Ward Leonard	40S1000
R301	115-0641	Fixed, Power, Axial	50 ohms	3 w	5%	Ward Leonard	3X50
R302	115-0630	Fixed, Molded	470 ohms	1 w	10%	Allen-Bradley	GB4711
R303	115-0559	Fixed, Molded	5.6 K ohms	1/2 w	5%	Allen-Bradley	EB5625
R304	115-0960	Fixed, Molded	1 K ohm	1 w	5%	Allen-Bradley	GB1025
R305	115-0444	Fixed, Power, Axial	300 ohms	3 w	5%	Ward Leonard	3X300
R306	115-0341	Fixed, Molded	100 ohms	1/2 w	5%	Allen-Bradley	EB1015
R307	115-0253	Fixed, Molded	82 K ohms	1/2 w	5%	Allen-Bradley	EB8235
R308	115-0512	Fixed, Power, Axial	1 K ohms	5 w	5%	Ward Leonard	5X1000
R309	115-0809	Fixed, Molded	100 K ohms	1/2 w	10%	Allen Bradley	EB1041
RL101	140-0040	Relay	3PDT			Kurman	26D3C

Schematic Part No.	Kepco Part No.	Description	Specifications			Mfr.	Mfr's. No.
S101	127-0107	Switch, Toggle	SPST			Carling	AA252-71-2
T201	100-1193	Transformer, Flux-O-Tran				Kepco	100-1193
T202	175-0399	Transformer, Variable				Superior	Q216U
T401	100-1179	Transformer				Kepco	100-1179
AZ/1N1372	109-0019	RECTIFIER ASSEMBLY Includes the following:					
1 ea.	121-0016	Reference Diode				Motorola	1N1372
AO/SP67B	110-0122	PASS ASSEMBLY (STAT) Includes the following:					
1 ea.	119-0037	Transistor, PNP				Motorola	SP67B*
2C0.2/SP67B	110-0116	PASS ASSEMBLY (STAT) Includes the following:					
2 ea.	115-0891	Resistor, Fixed, Power, Axial	0.2 ohm	5 w.	5%	Ward Leonard	7/8"-Y- 0.2 ohm Axiohm-5%
2 ea.	119-0037	Transistor, PNP				Motorola	SP67B*
2C0.2TC/SP67B	110-0123	PASS ASSEMBLY (STAT) Includes the following:					
2 ea.	115-0891	Resistor, Fixed, Power, Axial	0.2 ohm	5 w	5%	Ward Leonard	7/8"-Y-0.2 ohm Axiohm-5%
2 ea.	119-0037	Transistor, PNP				Motorola	SP67B*
1 ea.	127-0093	Switch, Thermostat	N.C.			Chatham Controls	DRSCORP73C

* = Field Replacement: Motorola 2N1167

BM00277

REVISIONS	DRAWN	CHKD.	APPD.	DATE



NOTE

1 – ALL VOLTAGES TAKEN UNDER CONDITIONS SPECIFIED ON MAIN SCHEMATIC.

2 – ALL CAPACITOR VALUES ARE GIVEN IN MICROFARADS, RESISTOR VALUES IN OHMS, UNLESS OTHERWISE NOTED. (K = 1,000 OHMS.)

TOLERANCE UNLESS OTHERWISE SPECIFIED: FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ± 1/2°

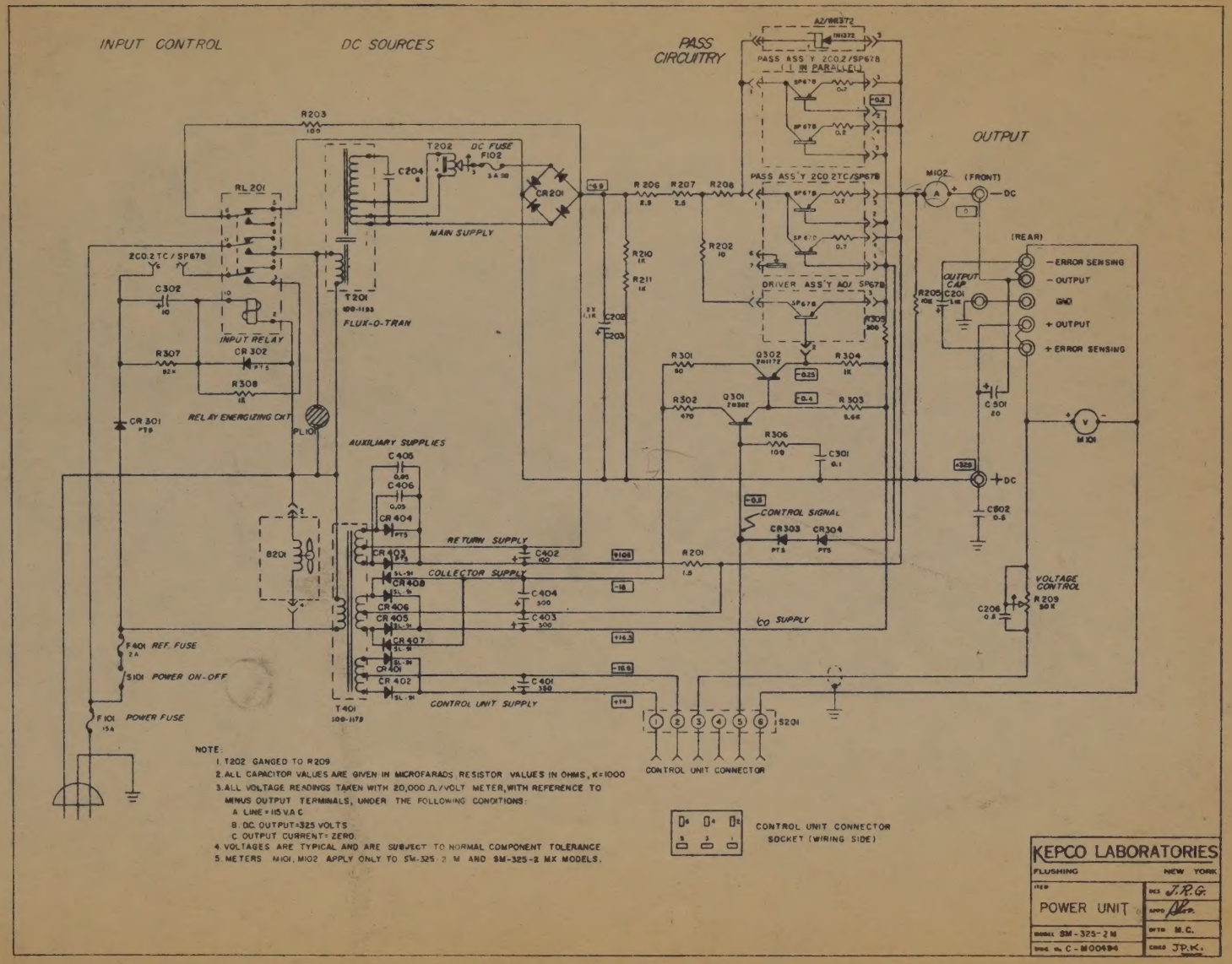
DEFIANCE NO. 100804 89791

KEPCO INC.
FLUSHING, N.Y.

TITLE
CONTROL UNIT

DRAWN	CHECKED	APPROVED	DATE
TJD	JPK.	MP	3-26-60
MODEL NO. TRAM 30		PART NO.	SCALE —

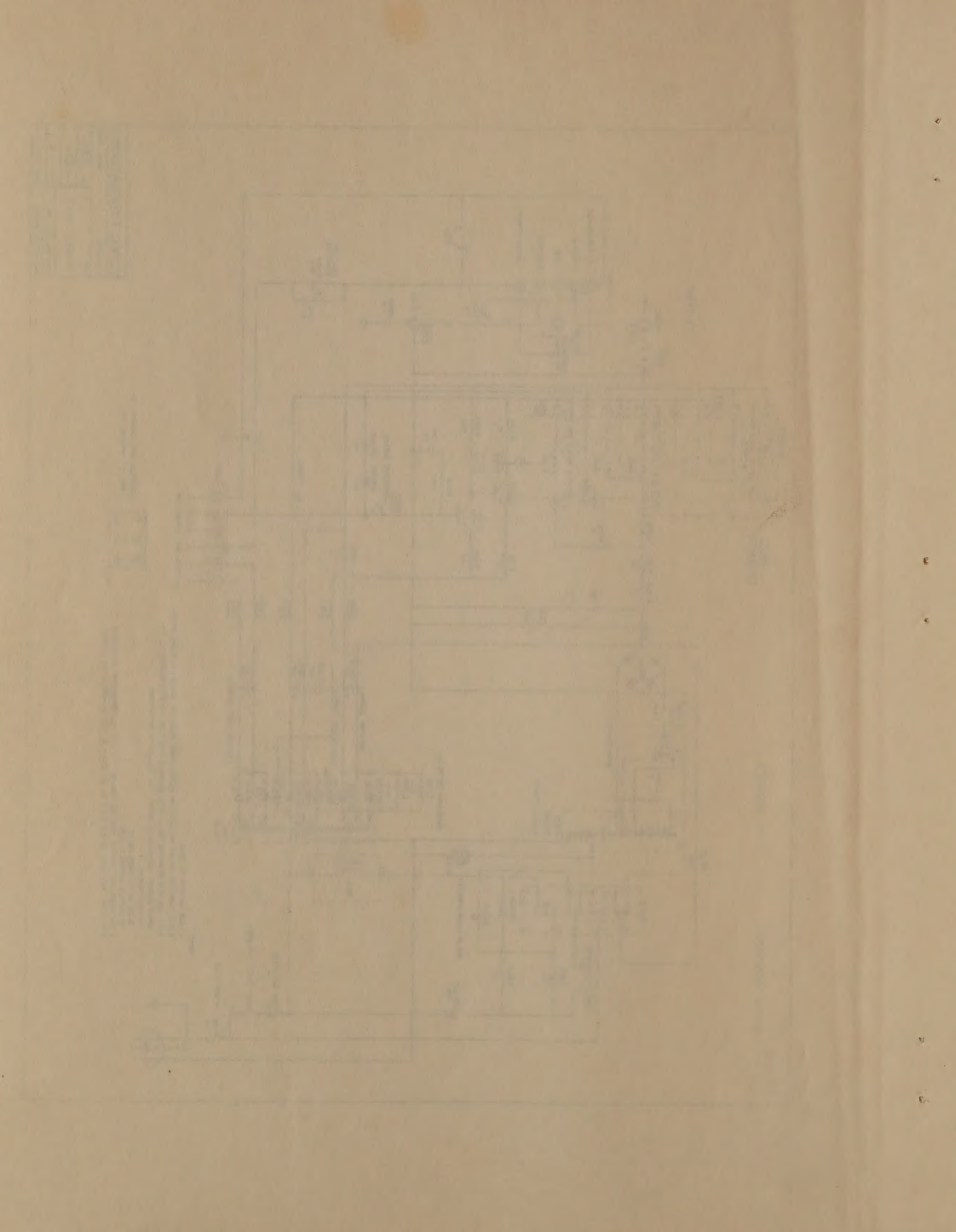
DWG. NO. BM00277



NOTE:
1. T202 GANGED TO R209
2. ALL CAPACITOR VALUES ARE GIVEN IN MICROFARADS RESISTOR VALUES IN OHMS, K=1000
3. ALL VOLTAGE READINGS TAKEN WITH 20,000 Ω/VOLT METER, WITH REFERENCE TO MINUS OUTPUT TERMINALS, UNDER THE FOLLOWING CONDITIONS:
   A. LINE = 115 VAC
   B. DC OUTPUT = 325 VOLTS
   C. OUTPUT CURRENT = ZERO.
4. VOLTAGES ARE TYPICAL AND ARE SUBJECT TO NORMAL COMPONENT TOLERANCE
5. METERS M101, M102 APPLY ONLY TO SM-325-2 M AND SM-325-2 MX MODELS.

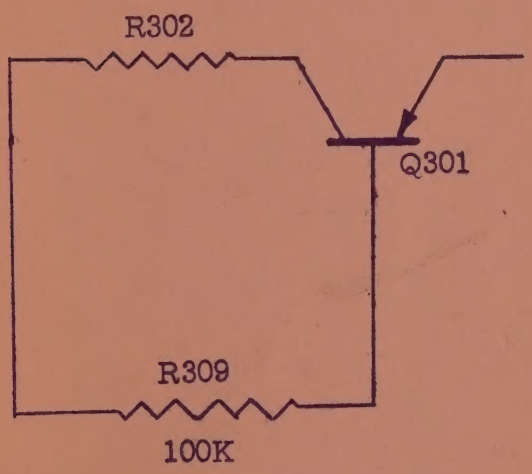
CONTROL UNIT CONNECTOR SOCKET (WIRING SIDE)

KEPCO LABORATORIES	
FLUSHING	NEW YORK
TITLE: POWER UNIT	DES J.R.G.
	APPD
MODEL SM-325-2M	DWN M.C.
DWG. No. C-M00494	CHKD J.P.K.



GENERAL CORRECTION SHEET FOR SM MODELS

Add R309 as shown to power unit schematic:



SM 14-30/37-60
36-15
75-8
160-4
325-2

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146-0045 2/65